

WHAT IS CLAIMED IS:

1. An interrogator for use in a communication system including, in addition to the interrogator as a first interrogator, a second interrogator, a first transponder, and a second transponder, the first interrogator comprising:

a carrier wave transmitter which transmits a first carrier wave toward the first transponder, so that the first transponder receives the first carrier wave, modulates the first carrier wave based on first information, and returns the modulated first carrier wave as a first reflected wave, toward the first interrogator;

a reflected wave receiver which receives the first reflected wave returned from the first transponder;

a demodulator which demodulates the first reflected wave received by the reflected wave receiver, into a demodulated signal;

an information obtaining device which obtains said first information from the demodulated signal;

a second carrier wave transmission judging device which judges, before the carrier wave transmitter transmits the first carrier wave, whether the second interrogator is transmitting a second carrier wave toward the second transponder so that the second transponder receives the second carrier wave, modulates the second carrier wave based on second information, and returns the modulated second carrier wave as a second reflected wave toward the second interrogator;

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a reflected wave reception judging device which judges, when the second carrier wave transmission judging device judges that the second interrogator is transmitting the second carrier wave, whether the reflected wave receiver can receive, as a third reflected wave, a modulated second carrier wave that has been modulated by the first transponder based on said first information and returned therefrom; and

a transmitter and receiver controller which controls, when the reflected wave reception judging device judges that the reflected wave receiver can receive the third reflected wave returned from the first transponder, the carrier wave transmitter not to transmit the first carrier wave, and additionally controls the reflected wave receiver to receive the third reflected wave.

2. The interrogator according to claim 1, wherein when the second carrier wave transmission judging device judges that the second interrogator is transmitting the second carrier wave, and when the reflected wave reception judging device judges that the reflected wave receiver cannot receive the third reflected wave returned from the first transponder, the transmitter and receiver controller controls the carrier wave transmitter to transmit, toward the first transponder, a third carrier wave having a frequency different from a frequency of the second carrier wave.

3. The interrogator according to claim 1, wherein the first and second interrogators can transmit, as a common

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carrier wave, the first and second carrier waves that have a same frequency, the first interrogator can transmit, as a first exclusive carrier wave, a third carrier wave having a frequency different from the frequency of the common carrier wave, and the second interrogator can transmit, as a second exclusive carrier wave, a fourth carrier wave that has a frequency different from the respective frequencies of the common carrier wave and the first exclusive carrier wave, and

wherein the second carrier wave transmission judging device judges whether the second interrogator is transmitting the second carrier wave as the common carrier wave, and does not judge whether the second interrogator is transmitting the fourth carrier wave as the second exclusive carrier wave.

4. The interrogator according to claim 3, wherein a power of each of the first and second carrier waves as the common carrier wave is smaller than a power of each of the third and fourth carrier waves as the first and second exclusive carrier waves.

5. The interrogator according to claim 3, further comprising an identification information transmitter which periodically transmits, when the carrier wave transmitter transmits the first carrier wave as the common carrier wave, at least one of (a) first identification information that identifies, in distinction from the second interrogator, the first interrogator

that is transmitting the common carrier wave and (b) second identification information that identifies the common carrier wave in distinction from each of the first and second exclusive carrier waves, such that said at least one of (a) the first identification information and (b) the second identification information accompanies the common carrier wave.

6. The interrogator according to claim 1, wherein the transmitter and receiver controller comprises a first carrier wave transmission stopping portion which periodically stops the carrier wave transmitter from transmitting the first carrier wave.

7. A transponder for use in a communication system including, in addition to the transponder as a first transponder, a second transponder, the first interrogator according to claim 3, and a second interrogator, the first transponder comprising:

- a carrier wave receiving and returning device which receives each of the common carrier receiver and the first exclusive carrier wave transmitted from the first interrogator;

- a subcarrier wave modulator which generates a subcarrier wave and modulates the subcarrier wave based on an information signal representing identification information that identifies the first transponder in distinction from the second transponder;

- a carrier wave modulator which modulates the

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common carrier wave received by the carrier wave receiving and returning device, based on the subcarrier wave modulated by the subcarrier wave modulator, so that the carrier wave receiving and returning device returns the modulated carrier wave as the first reflected wave;

a common carrier wave reception judging device which judges whether the carrier wave receiving and returning device is receiving the common carrier wave; and

a modulation controller which controls, when the common carrier wave reception judging device judges that the carrier wave receiving and returning device is receiving the common carrier wave, the carrier wave modulator to modulate the received common carrier wave, so that the carrier wave receiving and returning device returns the modulated carrier wave as the first reflected wave.

8. The transponder according to claim 7, further comprising an exclusive carrier wave reception judging device which judges whether the carrier wave receiving and returning device is receiving the first exclusive carrier wave transmitted from the first interrogator to the first transponder, the first exclusive carrier wave representing an interrogation directed from the first interrogator to the first transponder,

wherein the modulation controller comprises a modulation stopping portion which stops, when the exclusive carrier wave reception judging device judges that the carrier wave receiving and returning device is not receiving the first

exclusive carrier wave, a modulating operation of the carrier wave modulator for a pre-set time.

9. The transponder according to claim 7, wherein the modulation controller comprises a communication requesting portion which, when the first transponder operates to communicate with the first interrogator using the first exclusive carrier wave and when the common carrier wave reception judging device judges that the carrier wave receiving and returning device is receiving the common carrier wave, adds, to the information signal used by the subcarrier wave modulator to modulate the subcarrier wave, a communication requesting signal that requests the first interrogator to transmit the first exclusive carrier wave to the first transponder so that the first interrogator and the first transponder communicate with each other using the first exclusive carrier wave.

10. The transponder according to claim 7, wherein the subcarrier wave modulator comprises a frequency hopping portion which hops a frequency of the subcarrier wave.

11. A communication system including the first interrogator according to claim 3, a second interrogator, the first transponder according to claim 7, and a second transponder, wherein the first and second interrogators comprise a primary interrogator which primarily transmits the common carrier wave toward each of the first and second transponders, and a

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secondary interrogator which sends, to the primary interrogator, a common-carrier-wave-transmission requesting signal that requests the primary interrogator to transmit the common carrier wave so that the primary interrogator transmits the common carrier wave toward said each of the first and second transponders, and which subsequently is ready for receiving a corresponding one of the first and second reflected waves returned from the first and second transponders.

12. The communication system according to claim 11, wherein the primary interrogator transmits, together with the common carrier wave, an information signal comprising at least one of (a) a first identification signal that identifies the common carrier wave in distinction from each of the first and second exclusive carrier waves and (b) a second identification signal that identifies, in distinction from the secondary interrogator, the primary interrogator that is transmitting the common carrier wave.

13. The interrogator according to claim 1, wherein the carrier wave transmitter comprises a first antenna having a first range of directivity, and the reflected wave receiver comprises a second antenna having a second range of directivity, the first range of directivity being wider than the second range of directivity.

14. A communication system comprising:

a first interrogator and a second interrogator; and  
a first transponder and a second transponder,  
wherein the first interrogator comprises

a carrier wave transmitter which transmits a first carrier wave toward the first transponder so that the first transponder receives the first carrier wave, modulates the first carrier wave based on first information, and returns the modulated first carrier wave as a first reflected wave, to the first interrogator,

a reflected wave receiver which receives the first reflected wave returned from the first transponder,

a demodulator which demodulates the first reflected wave received by the reflected wave receiver, into a demodulated signal,

an information obtaining device which obtains said first information from the demodulated signal,

a second carrier wave transmission judging device which judges, before the carrier wave transmitter transmits the first carrier wave, whether the second interrogator is transmitting a second carrier wave toward the second transponder so that the second transponder receives the second carrier wave, modulates the second carrier wave based on second information, and returns the modulated second carrier wave as a second reflected wave, to the second interrogator,

a reflected wave reception judging device which judges, when the second carrier wave transmission judging device judges that the second interrogator is transmitting the second carrier wave, whether the reflected wave receiver can receive, as a third

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reflected wave, a modulated second carrier wave that has been modulated by the first transponder based on said first information and returned therefrom, and

a transmitter and receiver controller which controls, when the reflected wave reception judging device judges that the reflected wave receiver can receive the third reflected wave returned from the first transponder, the carrier wave transmitter not to transmit the first carrier wave, and additionally controls the reflected wave receiver to receive the third reflected wave,

wherein the first and second interrogators can transmit, as a common carrier wave, the first and second carrier waves that have a same frequency, the first interrogator can transmit, as a first exclusive carrier wave, a third carrier wave having a frequency different from the frequency of the common carrier wave, and the second interrogator can transmit, as a second exclusive carrier wave, a fourth carrier wave that has a frequency different from the respective frequencies of the common carrier wave and the first exclusive carrier wave,

wherein the second carrier wave transmission judging device judges whether the second interrogator is transmitting the second carrier wave as the common carrier wave, and does not judge whether the second interrogator is transmitting the fourth carrier wave as the second exclusive carrier wave, and

wherein the first transponder comprises

a carrier wave receiving and returning device which receives each of the common carrier receiver and the first

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exclusive carrier wave transmitted in distinction from the first interrogator,

a subcarrier wave modulator which generates a subcarrier wave and modulates the subcarrier wave based on an information signal representing identification information that identifies the first transponder in distinction from the second transponder,

a carrier wave modulator which modulates the common carrier wave received by the carrier wave receiving and returning device, based on the subcarrier wave modulated by the subcarrier wave modulator, so that the carrier wave receiving and returning device returns the modulated carrier wave as the first reflected wave,

a common carrier wave reception judging device which judges whether the carrier wave receiving and returning device is receiving the common carrier wave, and

a modulation controller which controls, when the common carrier wave reception judging device judges that the carrier wave receiving and returning device is receiving the common carrier wave, the carrier wave modulator to modulate the received common carrier wave, so that the carrier wave receiving and returning device returns the modulated carrier wave as the first reflected wave.

15. A communication system comprising:  
a first interrogator and a second interrogator; and  
a first transponder and a second transponder,

wherein the first interrogator comprises

a carrier wave transmitter which transmits a first carrier wave toward the first transponder so that the first transponder receives the first carrier wave, modulates the first carrier wave based on first information, and returns the modulated first carrier wave as a first reflected wave, to the first interrogator,

a reflected wave receiver which receives the first reflected wave returned from the first transponder,

a demodulator which demodulates the first reflected wave received by the reflected wave receiver, into a demodulated signal,

an information obtaining device which obtains said first information from the demodulated signal,

a second carrier wave transmission judging device which judges, before the carrier wave transmitter transmits the first carrier wave, whether the second interrogator is transmitting a second carrier wave toward the second transponder so that the second transponder receives the second carrier wave, modulates the second carrier wave based on second information, and returns the modulated second carrier wave as a second reflected wave, to the second interrogator,

a reflected wave reception judging device which judges, when the second carrier wave transmission judging device judges that the second interrogator is transmitting the second carrier wave, whether the reflected wave receiver can receive, as a third reflected wave, a modulated second carrier wave that has been modulated by the first transponder based on said first

information and returned therefrom, and

a transmitter and receiver controller which controls, when the reflected wave reception judging device judges that the reflected wave receiver can receive the third reflected wave returned from the first transponder, the carrier wave transmitter not to transmit the first carrier wave, and additionally controls the reflected wave receiver to receive the third reflected wave.

16. The communication system according to claim 15, wherein the first and second interrogators can transmit, as a common carrier wave, the first and second carrier waves that have a same frequency, the first interrogator can transmit, as a first exclusive carrier wave, a third carrier wave having a frequency different from the frequency of the common carrier wave, and the second interrogator can transmit, as a second exclusive carrier wave, a fourth carrier wave that has a frequency different from the respective frequencies of the common carrier wave and the first exclusive carrier wave, and

wherein the second carrier wave transmission judging device judges whether the second interrogator is transmitting the second carrier wave as the common carrier wave, and does not judge whether the second interrogator is transmitting the fourth carrier wave as the second exclusive carrier wave.